Manitoba Agriculture

MICRONUTRIENT INVESTIGATIONS ON ORGANIC SOILS 1985-87

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(A) COPPER:

Copper is an essential nutrient in crop production. It is required in relatively small amounts compared to major nutrients such as nitrogen and potassium. Therefore it is referred to as a micronutrient. Most mineral soils in Manitoba have levels of copper sufficient for crop production. However, in organic or peat soils copper deficiencies can be one of the major factors limiting crop production. In fact, the deficiencies at times can be extreme on these soils. Preliminary in field demonstrations in 1984 and 1985 showed that very large responses to copper fertilizer could be realized on deep organic soils in different regions of the province. A common observation in these demonstrations was yields in the nil range on the treatments that did not receive copper, whereas yields reached the 50-60 bushel per acre range on the copper treatments.

These preliminary observations lead to a series of more detailed investigations on deep organic soils in the Interlake and Eastern Regions. The investigations were set up with the following objectives in mind:

1. to compare different sources of copper fertilizer
2. to develop economic rates of application
3. to evaluate methods of application
4. to determine whether different times of application influence response.

Six investigations were initiated with barley in the Riverton, Stead and Whitemouth area during 1985-86-87. The barley variety in 1985 and 1986 was Argyle and Bedford in 1986. The observations are summarized as follows:

Response to Copper Fertilizer

Very large responses to copper fertilizer (table 1) were realized in three of the six investigations (see Riverton 1986, Whitemouth 1986 and Whitemouth 1987). On the three sites which

recorded responses the yields without copper fertilizer were very poor, (ranging from 2 to 19.3 bushels/acre). On these same three sites the average yield for all treatments that received copper fertilizer ranged from 28.0 to 51.1 bushels/acre. In one case the yields increased from 2.2 without copper to 82.5 bushels per acre by applying copper and the fungicide Tilt (Whitemouth 1987). The maximum response to copper at the other two responsive sites were: 2.0 to 48.4 bushels per acre at Whitemouth 1986 and 19.3 to 65.7 bushels per acre at Riverton 1986.

In this series of investigations crop response to copper fertilizer did not appear to be related to the amount of copper in the soil. The copper levels at all six sites were above the guideline used to flag possible deficiency problems on mineral soils (table 1). (On mineral soils deficiency problems may occur when copper levels in the soil are below 0.2 ppm). No response to fertilizer was observed on the Stead 1985 site which recorded the lowest soil copper level. However, on the site with the highest soil copper level (Whitemouth 1987) recorded an excellent response to additional copper fertilizer.

Sources of Copper Fertilizer

Three sources of copper fertilizer were compared; copper sulphate, EDTA chelate 7.5% copper and sequestered 5% copper. The products vary considerably in ease of application, costs and residual effect. Copper sulphate is a solid product (either granular of fine), can be difficult to apply, is very corrosive to fertilizer equipment and requires a substantial investment in the year of application. This form of copper may have a residual carry-over for a period of five to eight years. The EDTA chelate 7.5% copper and the sequestered 5% copper are liquid products and are relatively easy to apply (herbicide sprayers can be used). They require considerably less investment in the year of application than copper sulphate but reportedly do not have a residual effect after the year of application. EDTA copper chelate is more costly than sequestered copper. It is also reportedly a more effective source of copper than the sequestered product.

The effect of the three products on barley yield are compared in table 2. Two treatments, the fine grade copper sulphate and the dissolved and sprayed copper sulphate, although very effective in crop

response are not very practical for farm application. Copper sulphate is difficult to dissolve and once dissolved is very corrosive on most farm sprayer equipment. The problem with the fine grade copper sulphate is that most spin-type of fertilizer broadcast equipment is not able to apply it uniformly. Air-seeder type of fertilizer applicators should do a more uniform application of the fine grade copper sulphate; provided the product is not damp. If a spin-type of broadcast spreader is used, a granular form of copper sulphate can be applied more uniformly than the fine grade form. The fine grade can be less costly than the granular grade. Fertilizer equipment should be thoroughly washed after applying copper sulphate.

All three products, provided excellent responses to copper on the three responsive sites. The three products are compared in the following spring applied treatments; granular copper sulphate broadcast applied at 10 pounds copper, EDTA at 2 quarts and sequestered copper at 2 quarts per acre. The three site average yields for copper sulphate, EDTA and sequestered copper are as follows: 41.5, 57.2 and 50.3 bushels per acre respectively. At one site (Whitemouth 1987) applying copper sulphate in the previous fall produced significantly larger yields than a spring application. Economics, ease of application and residual effect should probably be the main factors in deciding which product to use.

Rates of Copper Fertilizer

When copper sulphate was the source of copper, the largest yields on 3 of 4 observations (table 2) were obtained with the 10 pound per acre copper treatment. The yields with lower rates of copper sulphate were usually considerably less. With EDTA copper chelate the average yields for the 2 and 1 quart rates were 57.2 and 51.1 bushels per acre respectively for the three sites. The added expense of the 2 quarts over the 1 quart/acre rate could not account for the extra 6.1 bushel per acre difference in yield.

Time of Copper Application

Yield comparisons for spring and fall application times are summarized in the Whitemouth 1987 investigation for granular grade copper sulphate and EDTA chelate, table 1. The fall application of

copper sulphate outyielded the spring application by a considerable 20.1 bushels per acre. However, with the two rates of EDTA, the spring applications outyielded the fall applications by 5 to 8 bushels per acre.

Methods of Copper Application

Three methods of applying copper sulphate were evaluated in 1986 at the Whitemouth and Riverton sites. The three methods included: (1) dissolving and spraying the copper sulphate on the soil surface followed by incorporation; (2) broadcast and incorporation of the granular product and (3) banding with the seed. Although dissolving and spraying produced the largest yields it is (as discussed before) not a practical farm method of application. Banding copper sulphate with the seed produced considerably less yield than the broadcast applications. The trials indicated that broadcast and incorporation is an effective and practical way of applying copper sulphate.

Foliar and preplant incorporation methods of application were evaluated for the EDTA chelate and the sequestered copper products. On two of the three sites the foliar application of EDTA was comparable to the preplant application but on the third site the yield was less than one-half. With the sequestered copper product the foliar applied yields were very much less than the yields on the preplant treatment.

SUMMARY

1. It is difficult to forecast a response to copper fertilizer by means of present day soil tests for copper on organic soils. The decision whether or not to fertilize with copper should be based on (a) recognizing deficiency symptoms in the field (b) tissue testing and (3) observed responses to application of copper to small areas of the field.

2. The three products; EDTA copper chelate, sequestered copper and granular copper sulphate are good sources of copper for cereal crops grown on deficient organic soils. When deciding which source to use consideration should be given to the economics, ease of application and the residual effect of these products.

3. For optimum results when using copper sulphate apply the equivalent of ten pounds of copper per acre as a broadcast treatment in the

fall. The copper sulphate should be incorporated prior to seeding. Do not band apply copper sulphate. Because copper sulphate reportedly provides a residual effect the cost of application should be considered over a 5 to 8 year period.

(4) EDTA copper chelate and sequestered copper fertilizers offer ease of application as compared to copper sulphate. The economics of product type and rate of application have to be considered. Results (table 2) show little yield difference between the 2 quart per acre sequestered and the 1 quart per acre EDTA preplant treatments. The two quart per acre EDTA treatment yielded only 6-7 bushels per acre more than the above two treatments. Spring applied EDTA will probably result in larger yields than fall applied.

(5) Foliar applications of EDTA chelate have merit as a salvage treatment. In cases where a deficiency is recognized very early in the growing season, a foliar application of 1 quart per acre EDTA may significantly increase the yield. Foliar applications may yield considerably less than the preplant treatments.

TABLE 1

BARLEY RESPONSE TO COPPER FERTILIZER

	Stead 1985	Riverton 1985	Riverton 1986	Whitemouth 1986	Whitemouth 1987	Riverton 1987
Without Copper Fertilizer	53.1	31.2	19.3	2.0	2.2	45.4
With Copper Fertilizer						
(a) average of all copper treatments	49.8	38.2	51.1*	28.0*	49.3*	42.5
(b) maximum observed yield			65.7	48.4	82.5	
Copper Levels in the Soil**	0.6 ppm	1.0 ppm	0.7 ppm	2.7 ppm	0.8 ppm	0.8 ppm

* Statistically significant response to copper fertilizer.

** According to mineral soil guidelines copper levels greater than 0.2 ppm in the soil are considered adequate for cereal crop production.

TABLE 2-COPPER FERTILIZER INVESTIGATIONS ON ORGANIC SOILS -
SUMMARY OF OBSERVATIONS ON SITES WITH A SIGNIFICANT RESPONSE

PRODUCT	METHOD OF APPLICATION	RATE (per acre)	BARLEY YIELD (bushels per acre) WHITEMOUTH/86	RIVERTON/86	WHITEMOUTH/87	3 SITE AVERAGE
No Copper Applied			2.0	19.3	2.2	7.9
Copper Sulphate	Dissolve, Spray & Incorporate	10 lb Cu	48.4	65.7	46.9	53.7
Granular Grade Copper Sulphate	Broadcast & Incorporate - spring	10 lb Cu	30.7	56.3	37.4	41.5
	- fall	10 lb Cu	-	-	57.5	
	- spring	5 lb Cu	11.4	57.4	-	
	- fall	5 lb Cu	-	-	22.7	
	- fall	2 lb Cu	-	-	8.5	
	Band with Seed	5 lb Cu	11.2	32.5	-	
		2 lb Cu	3.7	39.5	-	
Fine Grade Copper Sulphate	Broadcast & Incorporate -spring	10 lb Cu	-	-	58.9	
EDTA Chelate 7.5% Copper	Spray & Incorporate - spring	2 qts	47.2	61.9	62.4	57.2
	- fall	2 qts	-	-	57.2	
	- spring	1 qt	46.6	53.4	53.4	51.1
	- fall	1 qt	-	-	45.3	
	Foliar	1 qt	53.1	25.8	50.8	43.2
Sequestered 5% Copper	Spray & Incorporate - spring	2 qts	52.4	40.8	57.8	50.3
	Foliar	1 qt	38.4	14.6	-	
Granular Grade Copper Sulphate plus Tilt	Dissolve, Spray & Incorporate	10 lb Cu/acre plus 2 applications of Tilt at 0.2 qts/acre/application			82.5	

(B) MANGANESE:

Manganese like copper is an essential micronutrient in crop production. Soil conditions which may lead to manganese deficiencies in crops are a shallow peat topsoil layer (usually less than 14 inches in depth) over a high line mineral subsoil. These soil conditions are found in several areas of the province. Manganese deficiencies have been observed on barley crops in the southern part of Interlake in the Oak Hammock marsh area. Deficiencies have also been observed on barley grown on the shallow peat soils found in the swales of the ridge and swale landscape of the Interlake and Winnipegosis areas. The occurence of low temperatures and dry soils early in the season may also enhance the deficiency. During the growing season under favorable conditions, the crops may outgrow the deficiency symptoms. By then however, damage resulting in yield loss may have occurred.

Response to Manganese Fertilizer

Three field trials were conducted on soils with a shallow layer of peat topsoil in the Oak Hammock area during 1985 to 1987. A response to manganese fertilizer was recorded in only one (1985) of the three years even though the trials were located in close proximity of one another in the same field. The manganese levels of the three trial sites were above the level considered deficient on mineral soils. Some observations from the 1985 trial on which response to manganese was recorded were (table 4):

1. A yield response to manganese fertilizer was reported on all treatments receiving a manganese fertilizer.
2. Slight yield differences were observed between the various manganese treatments. However, these differences were not statistically significant. In other words for all general purposes the yields on the manganese treatments could be considered to be equal.
3. The most economic preemergent treatment was banding manganese sulphate with the seed to supply the equivalent of five pounds of manganese per acre with the seed. Increasing the rate had no further significant effect on the yield.

4. The two foliar treatments (dissolved manganese sulphate and sequestered manganese) were also effective in increasing the yield of barley. (The dissolving of manganese sulphate was difficult when preparing the solution for foliar application).

SUMMARY

It is difficult to predetermine whether or not a response to manganese fertilization will be attained on the high line soils with a shallow peat topsoil. A response to manganese was observed in only one out of three years in the same field. Producers concerned about a manganese problem may want to try the following:

- band apply manganese sulphate at the equivalent of 9-13 pounds manganese per acre with cereal crops

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TABLE 3 BARLEY RESPONSE TO MANGANESE FERTILIZER

(bu/acres)

	1985	1986	1987
Without manganese fertilizer	33.9	32.3	55.9
With manganese fertilizer (average of all manganese treatments)	45.2*	35.0	60.5
Manganese levels in the soil**	1.5 ppm	1.5 ppm	4.8 ppm

Location of trials: Oak Hammock

* Statistically significant response to manganese fertilizer.

** According to mineral soil guidelines manganese levels greater than 1 ppm in the soil are considered adequate for cereal crop production.

TABLE 4

1985 MANGANESE FERTILIZER INVESTIGATIONS ON ORGANIC SOILS

PRODUCT	METHOD OF APPLICATION	RATE (per acre)	YIELD (bu/acre)
No manganese applied			33.9
Manganese Sulphate	Broadcast and Incorporate	30 lbs Mn	44.2
	Band with Seed Broadcast and Incorporate	5 lbs Mn 10 lbs Mn	45.5
	Band with Seed	5 lbs Mn	45.2
	Band with Seed	8 lbs Mn	46.8
Micro-mate	Band with Seed	10 lbs Mn	48.2
Sequestered Manganese	Foliar	3 pints	43.6
Manganese Sulphate + Water + Agral-90 (surfactant)	Foliar	8 lbs Mn SO_4 20 gallons 1.6 pints	43.1